The Canadian National Calibration Reference Centre for *In-Vivo* Monitoring and the United States Department of Energy's International *In-Vivo* Intercomparison.

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INTRODUCTION

The Canadian National Calibration Reference Centre for *In-Vivo* Monitoring (1) and the United States Department of Energy (DOE) collaborated to offer an intercomparison program to whole body counting facilities in 1993. The HML fabricated the phantom shell and Battelle Pacific Northwest Laboratory filled the shell with radioactive tissue-substitute polyurethane to simulate a uniform fission-product distribution in soft tissues.

The choice of the four-year-old phantom (2) was made for two important reasons: following the Chernobyl reactor accident monitoring many children was necessary and it follows that any whole body counter that has to be used in emergencies should have a good range of calibrations for it to be effective; costs- the smaller phantom required much less tissue-substitute to fill it and the shipping costs were also lower for this small phantom.

The phantom contained ^{137}Cs 4.487 ± 0.076 kBq, ^{88}Y 18.90 ± 0.54 kBq and ^{40}K 851 ± 43 Bq (01-May-93, 1200 PST). Performance of the participating facilities was evaluated according to ANSI N13.30 "Performance criteria for radiobioassay" (3) which states that "For testing purposes ...(bias) shall be within -0.25 to 0.50" and "The relative precision ... shall be in absolute value less than or equal to 0.4".

PARTICIPANTS

The program began with 27 facilities in the intercomparison program; however, this number grew as word of the program spread. As a result, the original 27 facilities enrolled in the program grew to 35. Each counting system was coded so some facilities had multiple codes, for a total of 43. Some participants counted the phantom on several different whole body counters. For example, one facility had seven codes assigned to it.

Time estimates for the length of the program were made assuming that it would take one week to perform measurements and two weeks for shipping/handling the phantom

to the next facility. Thus, the length of the intercomparison was estimated to be 86 weeks. The program began in April 1993 and should have ended in December 1994; however, such factors as shipping delays, equipment breakdown, and customs contributed to the lengthening of the program. The program officially ended on 1-Aug-95, when the phantom arrived back at the HML from the last participant's laboratory.

RESULTS

The phantom, designated as P4C (Phantom 4 year old, item C), was filled with soft-tissue substitute material and an unknown quantity of multiple radionuclides. The activity in the phantom was homogeneously distributed throughout all sections and was proportional to the volume of that section. The phantom also contained ^{40}K homogeneously distributed in an amount similar to a Reference Child, to produce an accurate Compton background in the resulting spectra.

Each facility was asked to determine the identity and amount of the radionuclide(s) in the energy range 200 - 2000 keV. Each facility was asked to make an estimate of the "worst case" precision (WCP) (4) and estimate their Minimum Detectable Activity (MDA).

DISCUSSION

All facilities correctly identified the radionuclides in the phantom although some facilities did not report the activity for ^{88}Y as they had no calibration factors for this radionuclide. Most did not report an activity value for ^{40}K. Selected results are shown in and the Figs. 1 - 3. The complete set of data can be found elsewhere (4). The average shipping time was 6.3 days and the average time at a facility was 16.3 days; however, this time is not realistic due to the downtime of the counting system at one facility. If the 187-day layover at one facility is replaced with the actual time taken to do the measurements (seven days), the average facility time becomes 11.3 days. Total shipping plus facility time was 17.6 days, which is less than the assumed three weeks used for planning purposes. The 21-day time-frame will be used for the next intercomparison scheduled for early 1996.

Bias results: Fig. 1 shows the bias results for ^{137}Cs as a function of counting geometry. Other data showed that size dependency was not a simple function of the type of counting geometry but must be a mixture of factors such as distance of the phantom from the detector(s), scan length (where applicable), size of detector, calibration coefficients etc. A similar analysis was performed on the ^{88}Y results (not shown) and the same trends were seen.

It is interesting to note that most of the facilities overestimated the activity in the phantom; however, when size corrected calibration factors were applied the results (not shown) become much more normal for ^{137}Cs. Most facilities underestimated the ^{88}Y when using size corrected calibration factors. The data in the final report (4) will be

useful for facilities that wish to redefine their calibration factors.

Fig. 1 shows that no one type of counting geometry appeared better than another. Representatives of all counting geometry types fell within the N13.30 acceptable limits mentioned above.

Precision results: Fig 2 shows the WCP results for ^{137}Cs. Normal precision values for these facilities will be much less than the values reports here. All facilities fall within the N13.30 guidelines for precision. Similar to the bias results, there appeared to be no one counting geometry that was superior to another.

MDA results: Figure 3 shows the MDA as a function of counting geometry. As the photon energy rises both the counting efficiency and the background count rate drop. Therefore, one would expect the ^{88}Y MDA's (not shown) to be lower than the ^{137} Cs values. The data showed this to be true for most facilities; however, for a few facilities the reverse was true, and the ^{88}Y MDA was higher than the ^{137} Cs value. As before, there was no correlation with counting geometry. One would have expected to see a correlation between ^{137}Cs MDA and counting time; however, the data showed that this was not true. Although there was a general drop in MDA as counting time was increased there was much scatter in the data. The data clearly showed that there was a large difference between ambient background count rates and/or detector shielding at the participating facilities (4).

REFERENCES

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3. American National Standards Institute. Performance Criteria for Radiobioassy. Draft ANSI N13.30, 1994

4. Kramer G.H.; Loesch R.M.; Olsen P.C. The Canadian National Calibration Reference Centre for *In-Vivo* Monitoring and the United States Department of Energy: Results of the 1993 Intercomparison/Intercalibration - Final Report. Human Monitoring Laboratory. Technical Document HMLTD-95-3; 1995

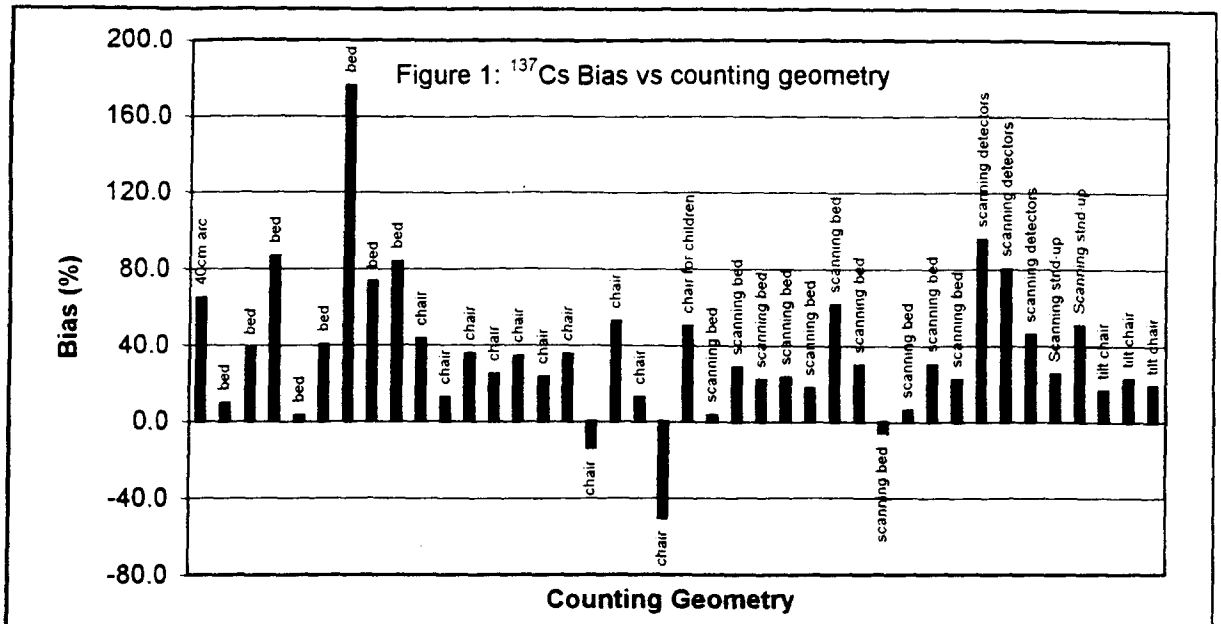
Figure 1: ^{137}Cs Bias vs counting geometry
Bias (%)
200.0
160.0
120.0
80.0
40.0
0.0
-40.0
-80.0
40cm arc
bed
chair
chair for children
scanning bed
scanning detectors
Scanning stnd-up
tilt chair
Counting Geometry

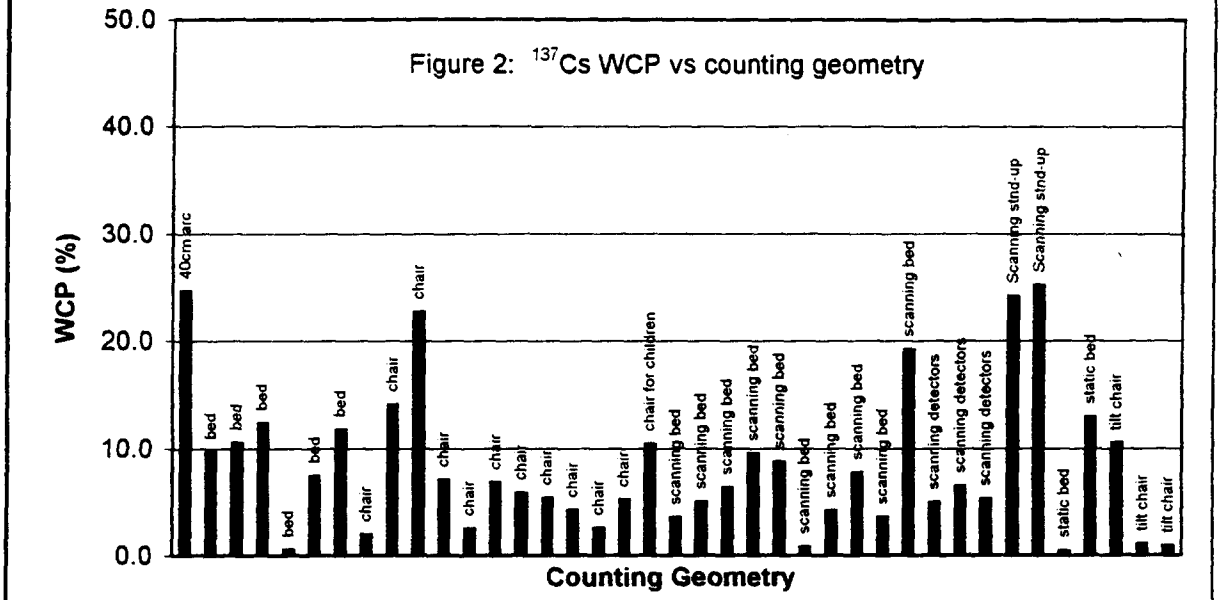
Figure 2: ^{137}Cs WCP vs counting geometry
WCP (%)
50.0
40.0
30.0
20.0
10.0
0.0
40cm arc
bed
chair
chair for children
scanning bed
scanning detectors
Scanning stnd-up
static bed
tilt chair
Counting Geometry

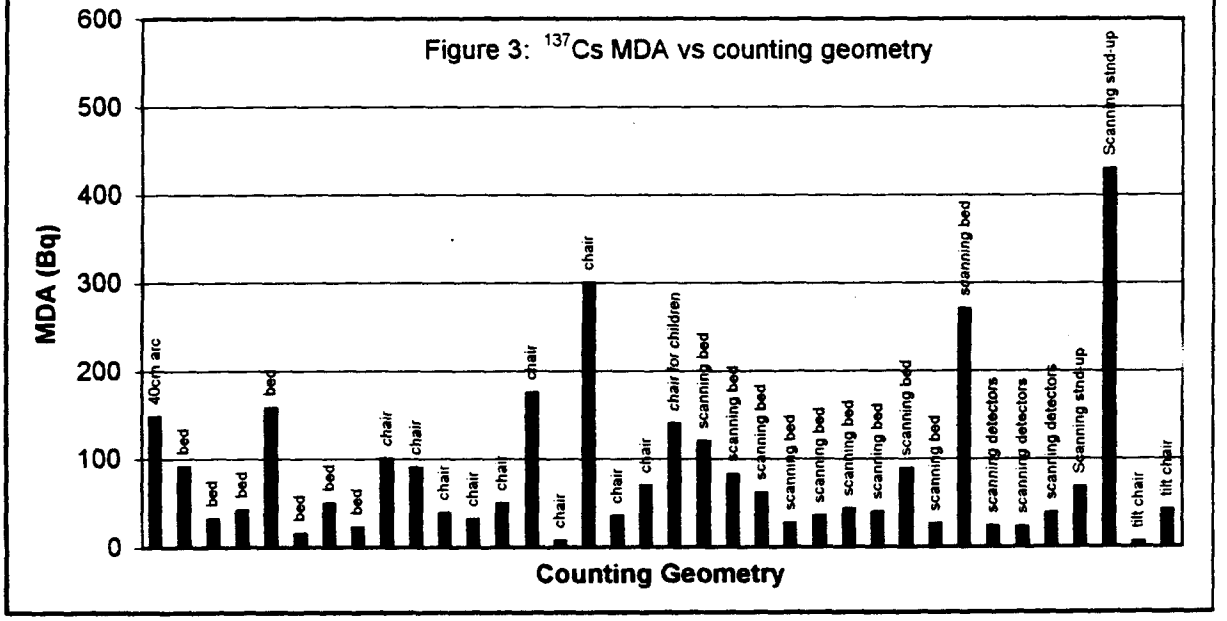
Figure 3: ^{137}Cs MDA vs counting geometry
MDA (Bq)
600
500
400
300
200
100
0
40cm arc
bed
chair
chair for children
scanning bed
scanning detectors
Scanning stnd-up
tilt chair
Counting Geometry